A Comprehensive Analysis of Power Consumption and Resources Utilization in Open-Source and Proprietary Media Players

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Engineering Graduate Seminar
Memorial University of Newfoundland (Faculty of Engineering and Applied Science)
October 2024

MEMORIAL UNIVERSITY

Contents

Introduction

- Media players are widely used across various platforms, and their power consumption has become increasingly important due to the growing demand for high-definition video playback.
- Open-source and proprietary media players offer different benefits, with proprietary players generally focused on performance and hardware optimization, while open-source players offer flexibility and broad codec support.
- Understanding the power consumption differences between open-source and proprietary players is crucial for users and industries prioritizing energy use.

Introduction

- The study investigates how hardware acceleration, codec support, and system configurations impact the overall power efficiency of media players, particularly in high-performance scenarios like 4K video playback.
- Addressing power efficiency in media software not only benefits individual users but also contributes to broader environmental sustainability efforts.
- This thesis aims to provide a comprehensive comparison of power consumption, resources utilization, and usability between the two categories of media players.

Literature Review

Author	Focus	Findings	Methodology	Contribution	Citation
Santos et al.	Power profiling with hardware counters	Proprietary uses less power	Hardware counters, system calls	Highlighted hardware optimization	[1]
Chen et al.	OSS media player efficiency	VLC excels in GPU usage	Video playback with modern codecs	Showed OSS GPU efficiency	[2]
M Dahmani et al	CPU usage in OSS	High CPU in Linux environments	Analyzed OSS on different platforms	Identified driver limits	[3]
Panayides et al.	Open-source codecs	Higher CPU with VP9, AV1	Codec performance testing	Trade-offs in codec use	[4]

Literature Review

Media Player	OS Support	Codec Support	Notable Limitations
VLC (3.0.11)	Windows Ubuntu	H.264, H.265, VP9, AV1	Higher CPU power consumption on Ubuntu [5]
MPV (0.33.0)	Windows, Ubuntu	H.264, H.265, VP8, VP9, AV1	Better GPU utilization on Windows than Ubuntu [6]
Kodi (19.0)	Windows, Ubuntu	H.264, HEVC, MPEG-2, VP9	Higher CPU power usage on Ubuntu [7]
MPC-HC (1.9.11)	Windows	H.264, HEVC, VP9	Not available on Ubuntu, lacks hardware acceleration [8]
SM Player (1.8.9)	Windows, Ubuntu	H.264, H.265	Less popular, limited features compared to VLC [9]
Totem (3.38)	Ubuntu	H.264, Theora, VP8	Limited codec support, higher CPU usage on Ubuntu [10]
Parole (4.14.0)	Ubuntu	H.264, Theora	Lacks advanced features, high CPU power usage [11]

Research Question

- How does the power consumption of open-source media players compare to proprietary media players during high-resolution video playback?
- What impact do hardware acceleration and driver optimizations have on the energy efficiency of media players across different platforms?
- How does codec support influence the energy consumption of media players, and which codecs offer the best balance between performance and energy use?
- What are the long-term implications of using open-source versus proprietary media players in terms of energy consumption and sustainability?

Platforms

- Windows:
  - Widely used platform with strong hardware acceleration support.
- Ubuntu:
  - OS with varying driver support for hardware acceleration.

Tools Used

- HWiNFO:
  - Real-time system monitoring tool for Windows.
  - Tracks CPU/GPU power consumption, utilization, and temperatures.
- PowerTOP:
  - Linux tool for power consumption monitoring.
  - Identifies processes and applications consuming the most power.
- Microsoft Excel / Data Analysis Software:
  - Used for data recording, analysis, and visualization.

Test Scenarios

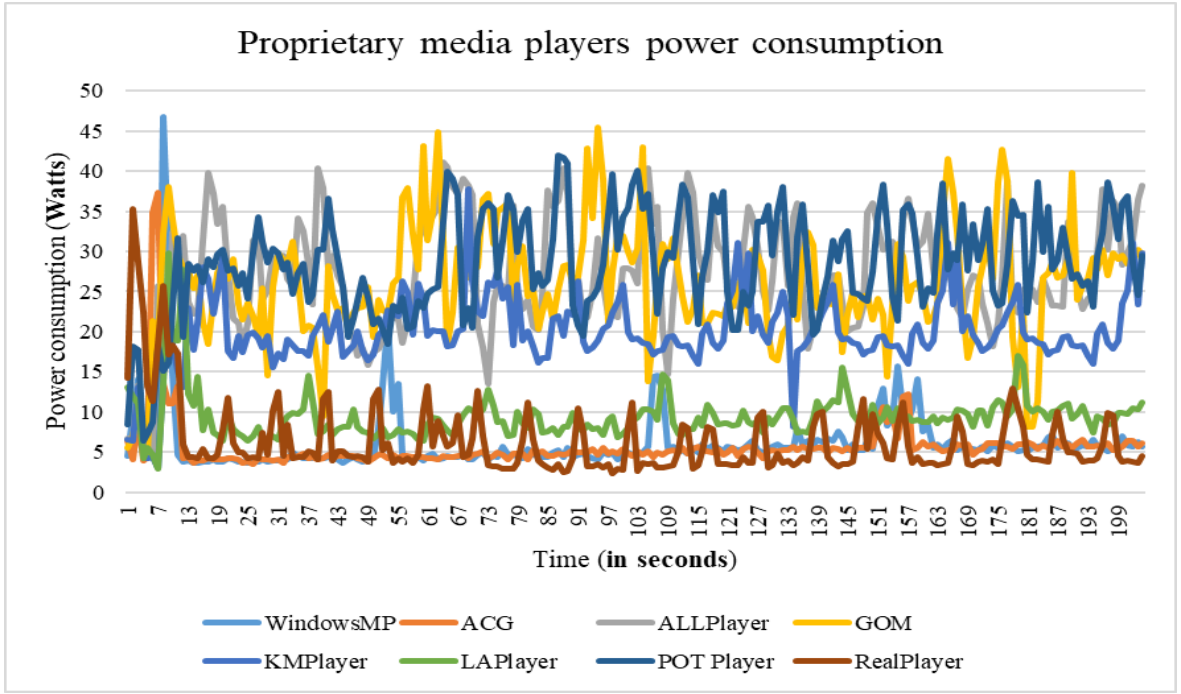
- Video Playback Tests:
  - High-resolution 4K video files.
  - Raw video formats to maximize resource usage.
- Codec Variations:
  - Testing with different codecs: H.264, H.265, VP9, AV1.
- Playback Sessions:
  - Multiple playback sessions to ensure data consistency.
- Controlled Environment:
  - No background applications running.
  - System settings standardized (e.g., performance mode).

Metrics for Analysis

- Power Consumption:
  - CPU and GPU wattage during playback.
- CPU Utilization:
  - Percentage of CPU resources used.
- GPU Utilization:
  - GPU load during video decoding.
- Memory Usage:
  - RAM consumption by media players.

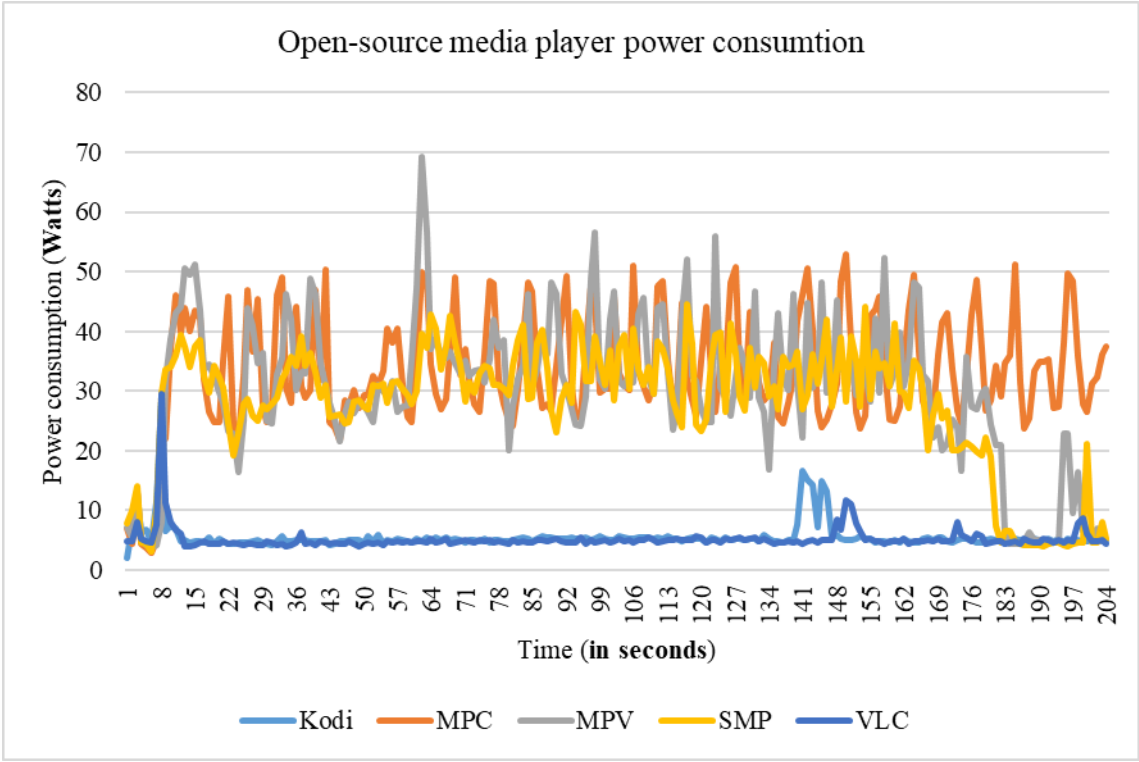
Results Comparison - Power Consumption on 4K videos

- Proprietary Media players:
  - Proprietary media players, on average, consume less power.
  - Reason could be correct use of the video drivers or different technique of decompression of MP4 file.



Results Comparison - Power Consumption on 4K videos

- Open-Source Media players:
  - MPC a high-power-consuming media player(33.51 W)
  - VLC a low-power-consuming media player (5.14 W)



Results Comparison – CPU and Memory Utilization on 4K video

Media Player	Average CPU Power Consumption (W)	Average memory usage (MBs)
Kodi	5.5	7442.0
Media Player Classic	33.5	8797.4
MPV	30	6438.9
SMP	27.7	6438.9
VLC	5.1	7265.1

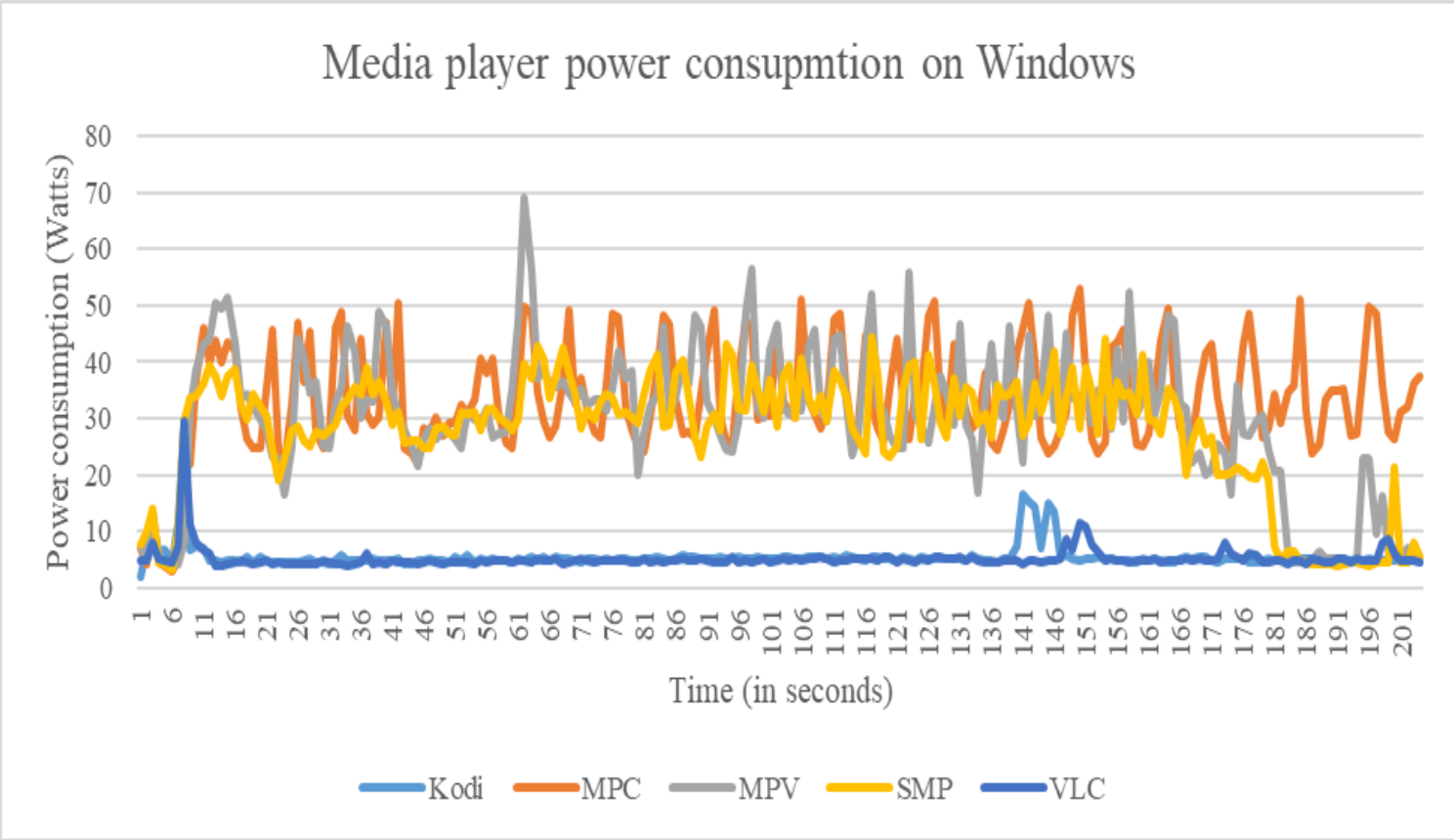
Media Player	Average CPU Power Consumption (W)	Average memory usage (MBs)
Windows Media Player	6.1	7688.6
ACG	5.6	8345.4
ALLPlayer	27.2	8322.6
GOM Player	25.9	7988.6
KM Player	19.9	8922.3
LA Player	9.4	9484.2
POT Player	28.4	9112.6
Real PLayer	6.3	6430.6

Discussion

- Results reveals that proprietary media players generally consume less power than open-source.
- For clearer results following things need to be considered:
  - Experiment on different operating system
  - Experiment on raw video file
  - Experiment on open-source video file format

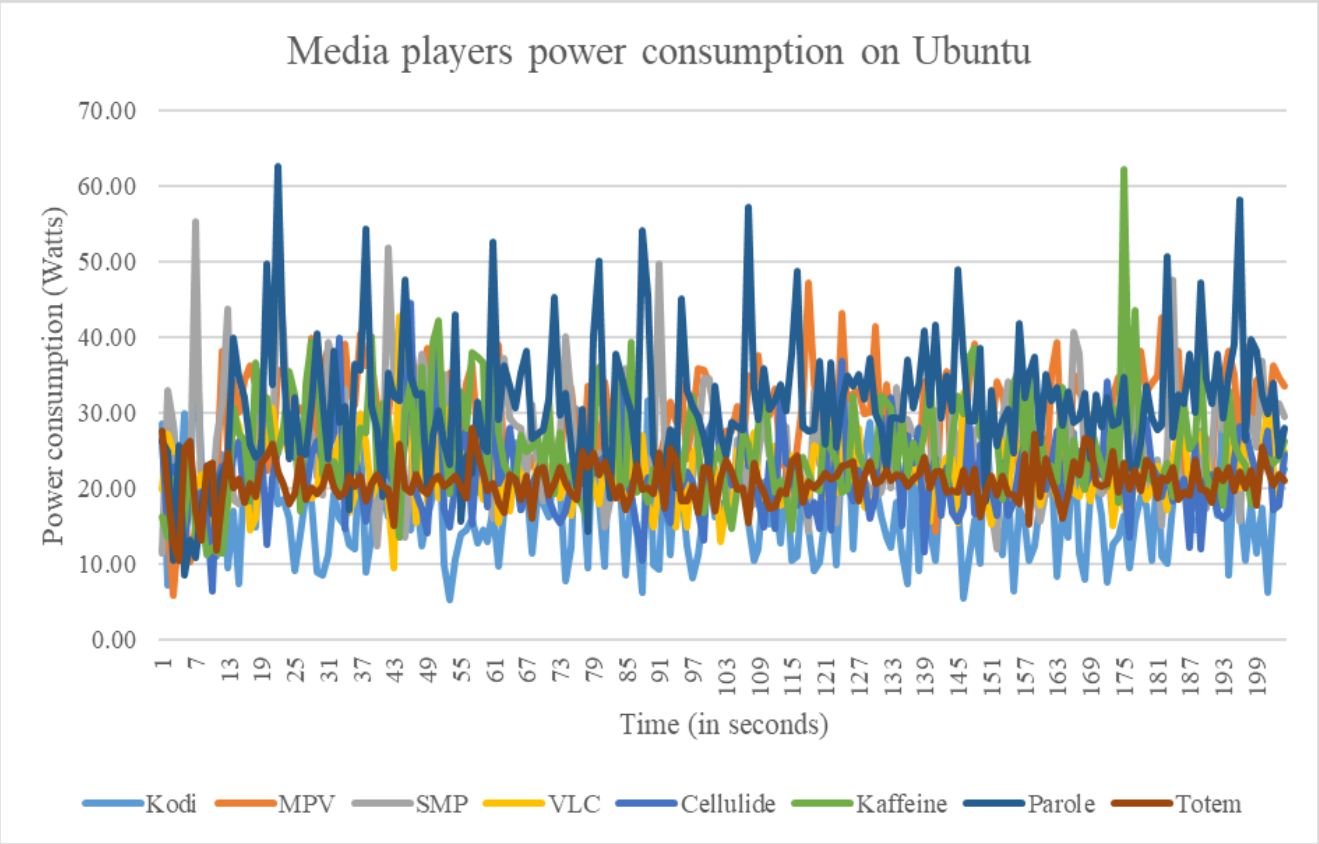
Results – Platform Performance (Windows)

- Findings:
  - Proprietary players on Windows utilized hardware acceleration effectively.
  - Lower CPU usage and power consumption.
  - Strong driver support enhanced performance.



Results – Platform Performance (Ubuntu)

- Findings:
  - Open-source players on Ubuntu showed higher CPU usage.
  - Limited driver support affected hardware acceleration.
  - Increased power consumption during high-resolution playback.



Results Comparison – GPU usage comparison

- Media players on Windows tend to utilize GPU resources more efficiently.
- MPC (83.60%) and MPV (77.70%) on Windows exhibit the highest GPU utilization, indicating that they offload more processing to the GPU.
- On Ubuntu, Totem (89.09%) and Kaffeine (69.53%) leverage the GPU most effectively.
- However, GPU usage remains lower across the board on Ubuntu compared to Windows.

Player	GPU Usage (Windows)	GPU Usage (Ubuntu)
Kodi	33.54%	4.23%
MPC	83.60%	N/A
MPV	77.70%	64.44%
SMP	73.77%	14.38%
VLC	38.93%	7.65%
Celluloid	N/A	51.69%
Kaffeine	N/A	69.53%
Parole	N/A	9.89%
Totem	N/A	89.09%

Results Comparison – Memory usage comparison

- Memory consumption is typically higher on Windows.
- MPC on Windows consumes the most memory, with 8797.43 MB.
- Kaffeine on Ubuntu is the most efficient in terms of memory consumption at 2619.59 MB.
- Media players on Ubuntu consistently consume less memory compared to their counterparts on Windows.

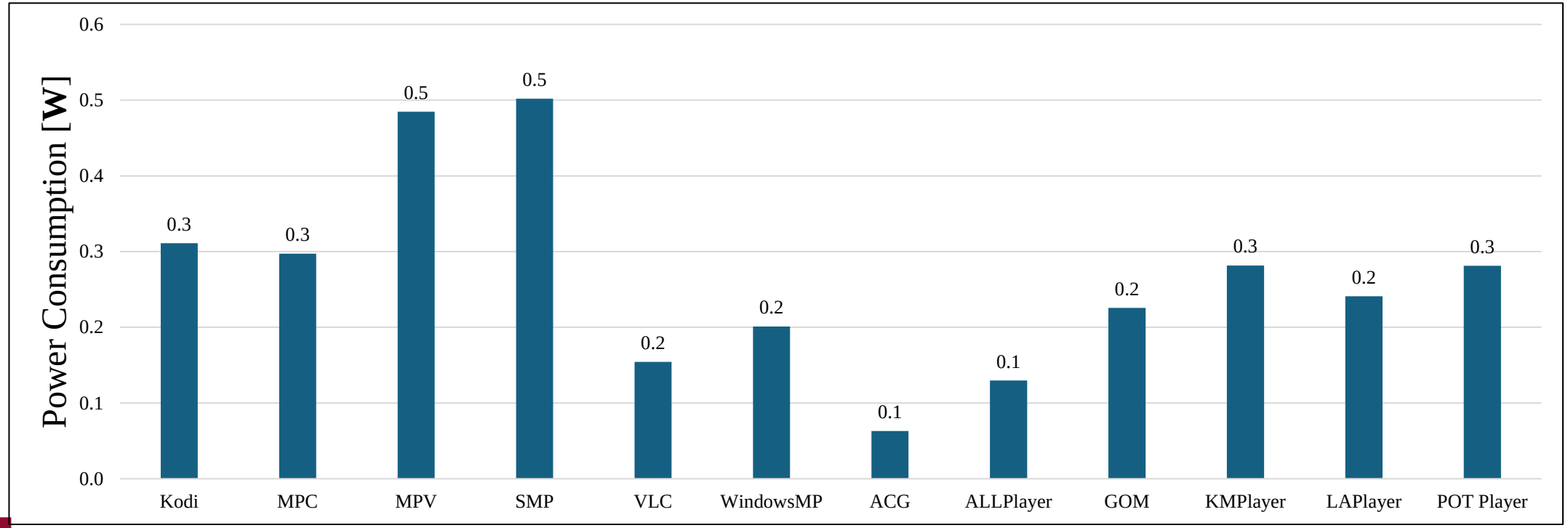
Player	Memory Usage (MB) (Windows)	Memory Usage (MB) (Ubuntu)
Kodi	7441.99	2928.46
MPC	8797.43	N/A
MPV	6438.90	2634.36
SMP	6438.90	3530.63
VLC	7265.10	3264.87
Celluloid	N/A	2923.91
Kaffeine	N/A	2619.59
Parole	N/A	2465.98
Totem	N/A	4456.13

Cross-Platform Performance Comparison

- Key Observations:
  - Proprietary players perform consistently better on Windows.
  - Open-source players face challenges on Ubuntu due to driver issues.
- Conclusion:
  - Platform-specific optimizations are crucial for energy efficiency.
  - Cross-platform compatibility impacts media player performance.

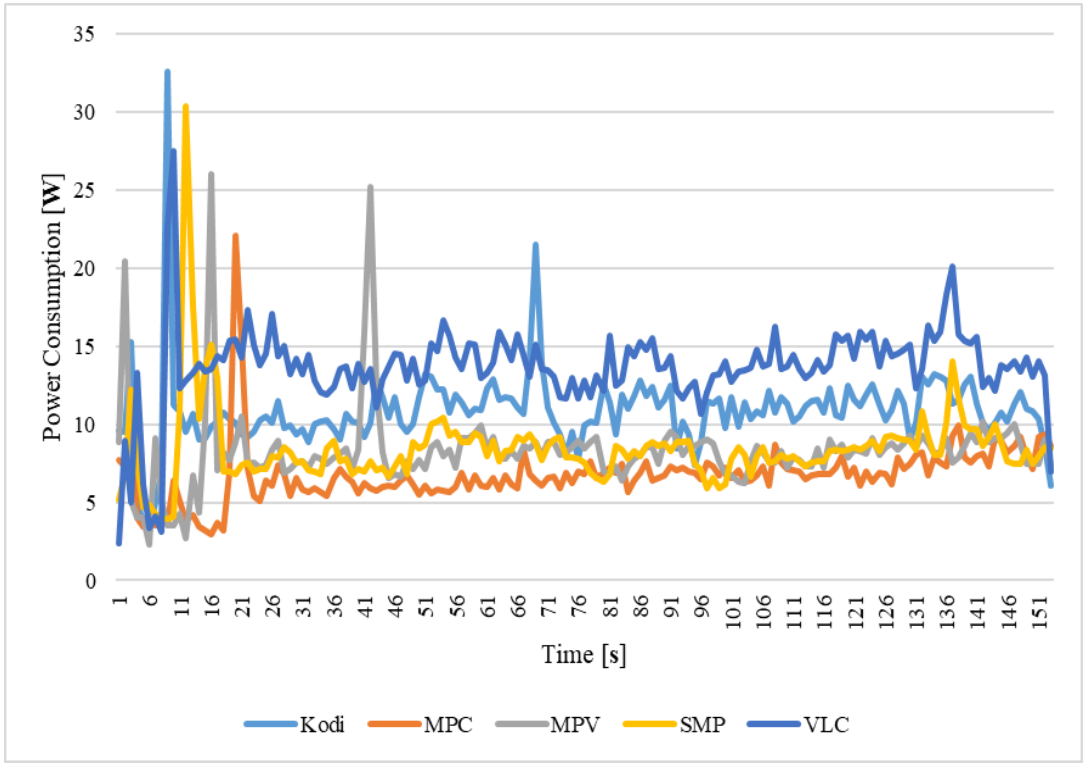
Results Comparison – GPU Utilization while playing raw video format

- Open-source media players have slightly higher average GPU power consumption as compared to proprietary players



Results Comparison - Power Consumption on Raw Video

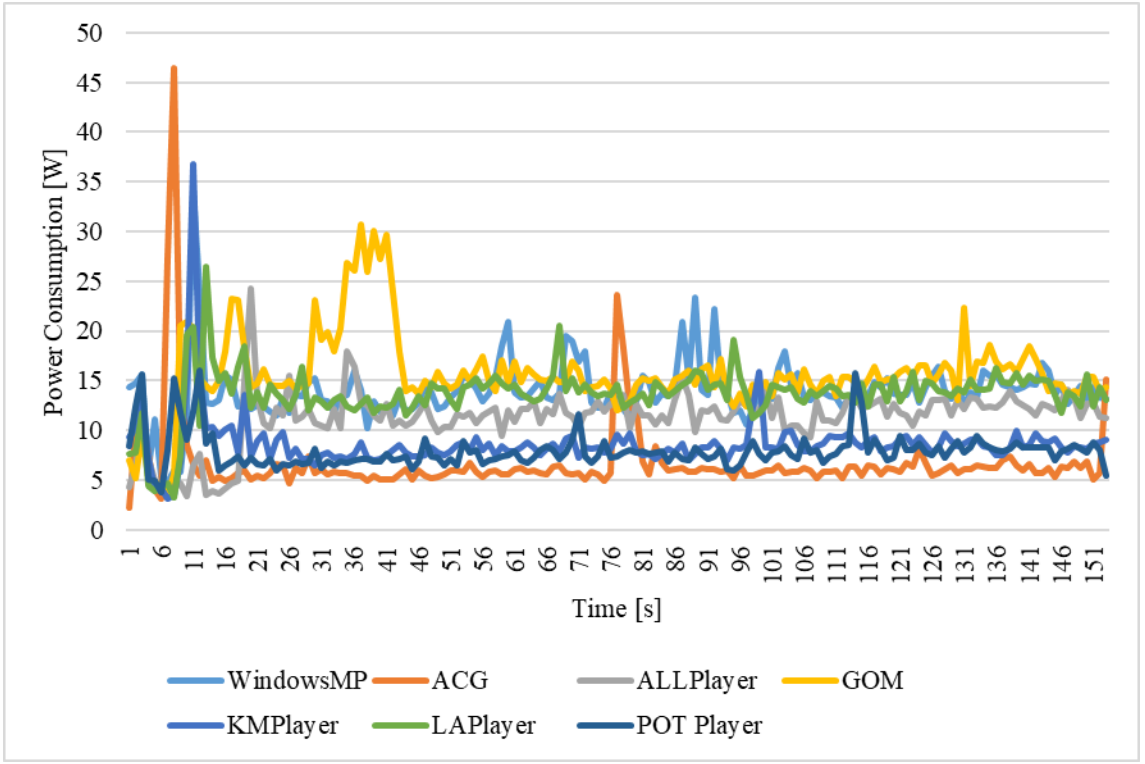
- Open-source media players tend to use less power.
- The average CPU power consumption for open-source media players was approximately 9.6 watts.



CPU Power consumption (W) of open-source media players

Results Comparison - Power Consumption on Raw Video

- Proprietary media players use more power.
- Proprietary media players consumed an average of 11.2 watts



CPU power consumption (W) by proprietary media players

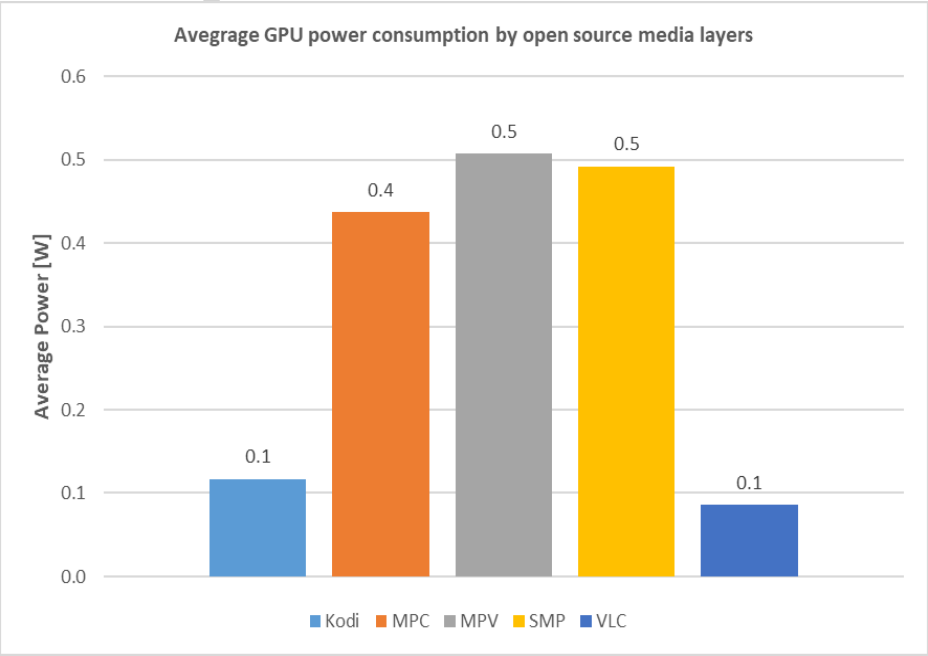
Results Comparison - CPU and Memory Utilization on raw format video

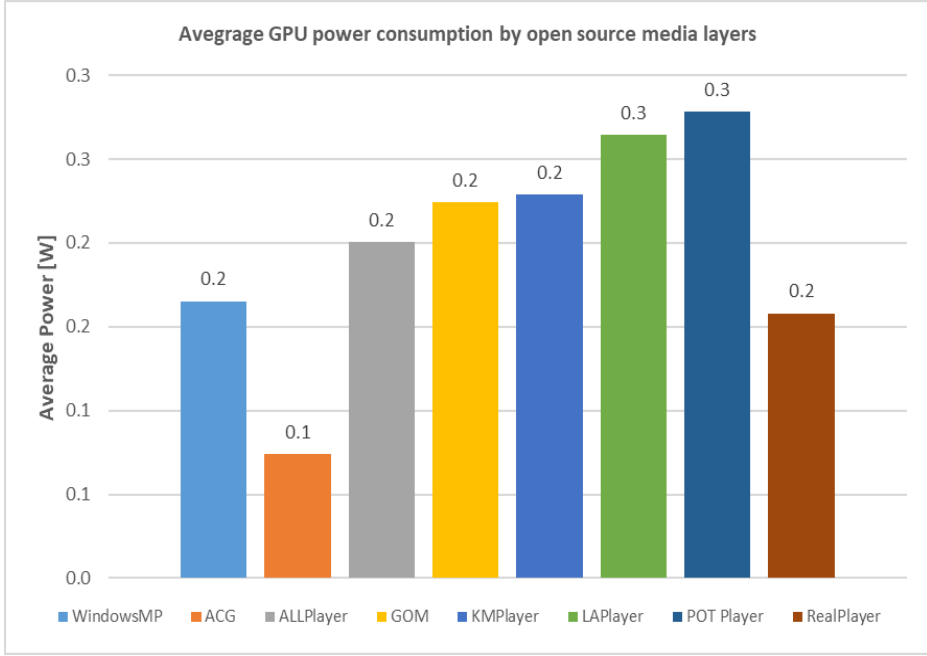
Media Player	Average CPU Power Consumption (Watts)	Average Memory Usage (MB)
Kodi	10.9	8,074.0
MPC	6.8	7,984.2
MPV	8.3	8,293.3
SMP	8.4	8,176.0
VLC	13.6	7,899.0

Media Player	Average CPU Power Consumption (Watts)	Average Memory Usage (MB)
WindowsMP	13.9	9,097.4
ACG	6.7	10,263.9
ALLPlayer	11.3	8,608.4
GOM	15.7	8,754.7
KMPlayer	8.6	8,051.7
LAPlayer	13.7	7,938.6
POT Player	7.9	7,872.5

Results Comparison – GPU Utilization while playing open media format (.webm)

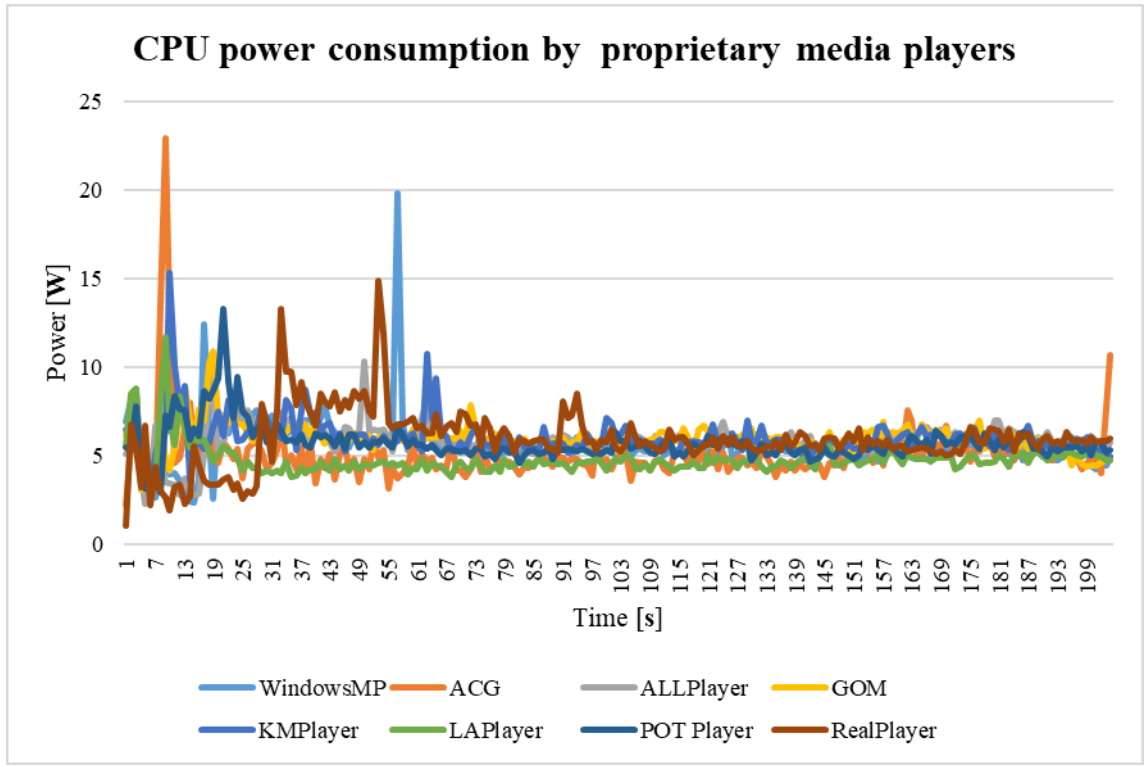
- Open-source media players exhibited higher GPU power consumption
- Proprietary media players demonstrated lower GPU power consumption.





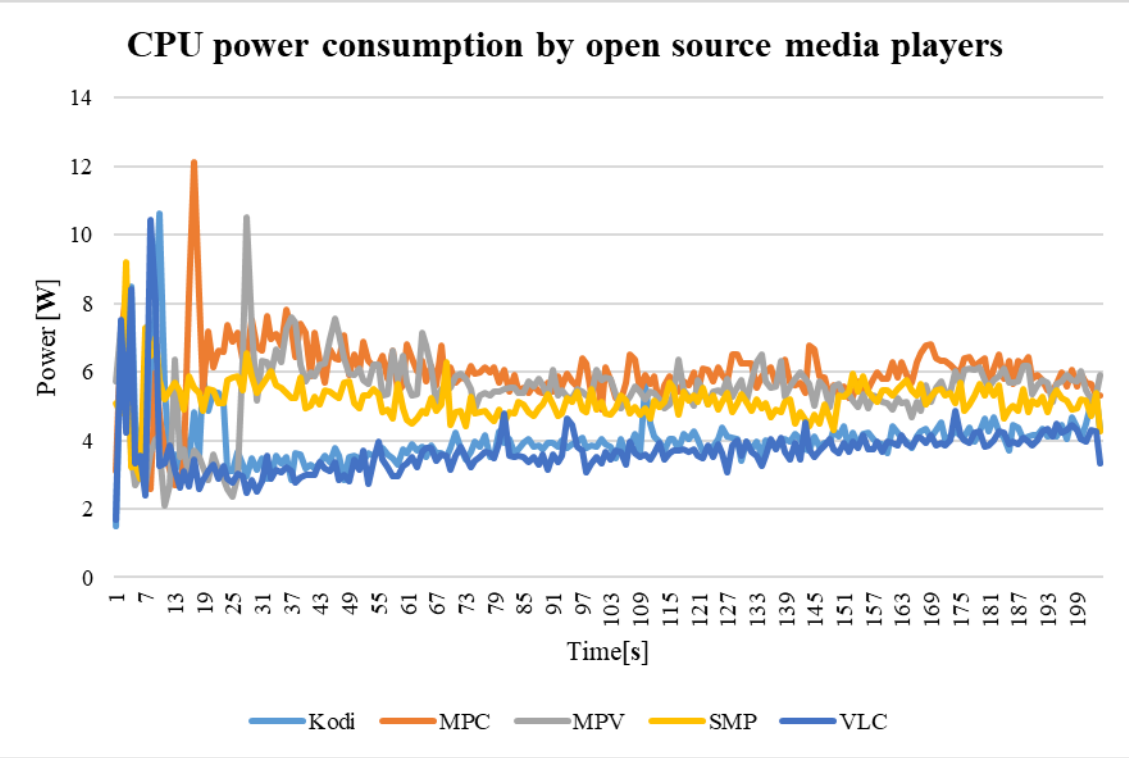
Results Comparison - Power Consumption on Open media format video (.webm)

- VLC and Kodi showed the lowest CPU power consumption at 3.68 W and 4.03 W, respectively.
- MPV had the highest CPU power consumption among open-source players at 5.96 W



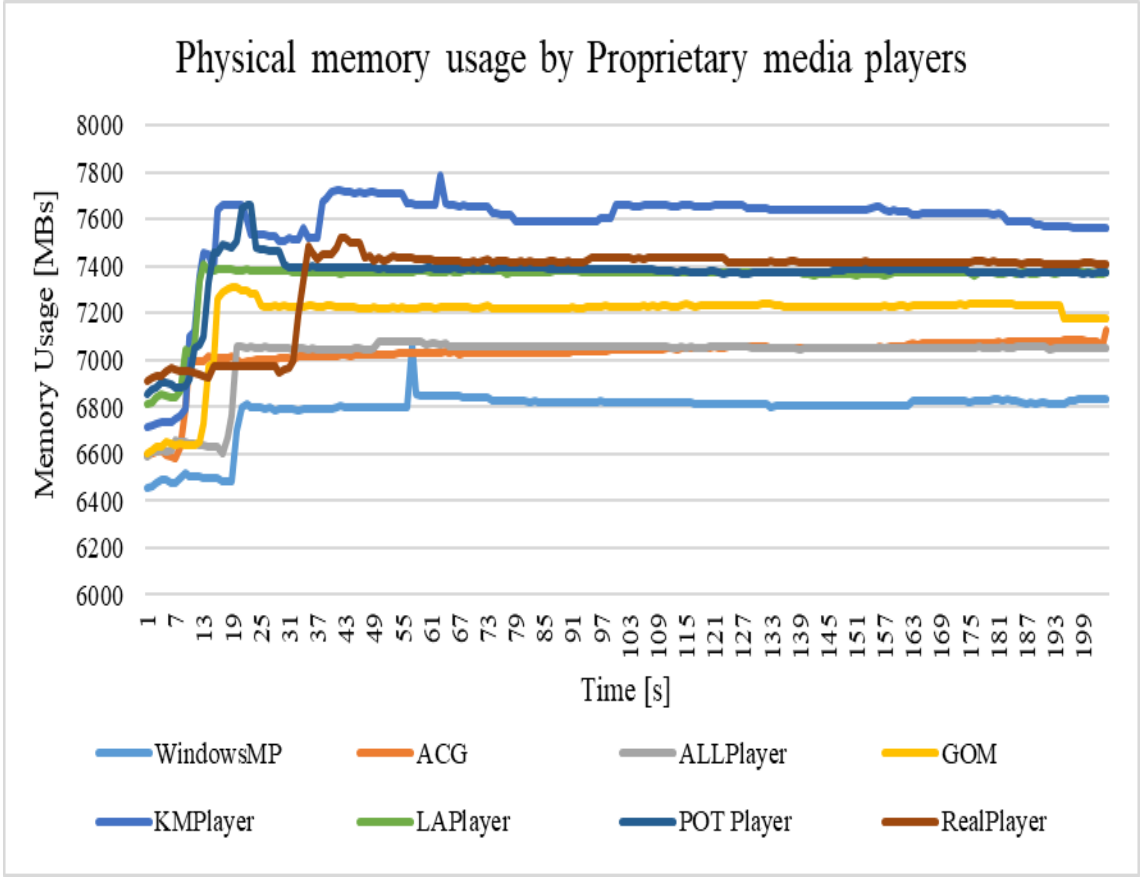
Results Comparison - Power Consumption on Open media format video (.webm)

- KMPlayer consumed 6.02 W, and Windows Media Player consumed 5.56 W.
- Reflecting slightly higher CPU power usage compared to their open-source counterparts.



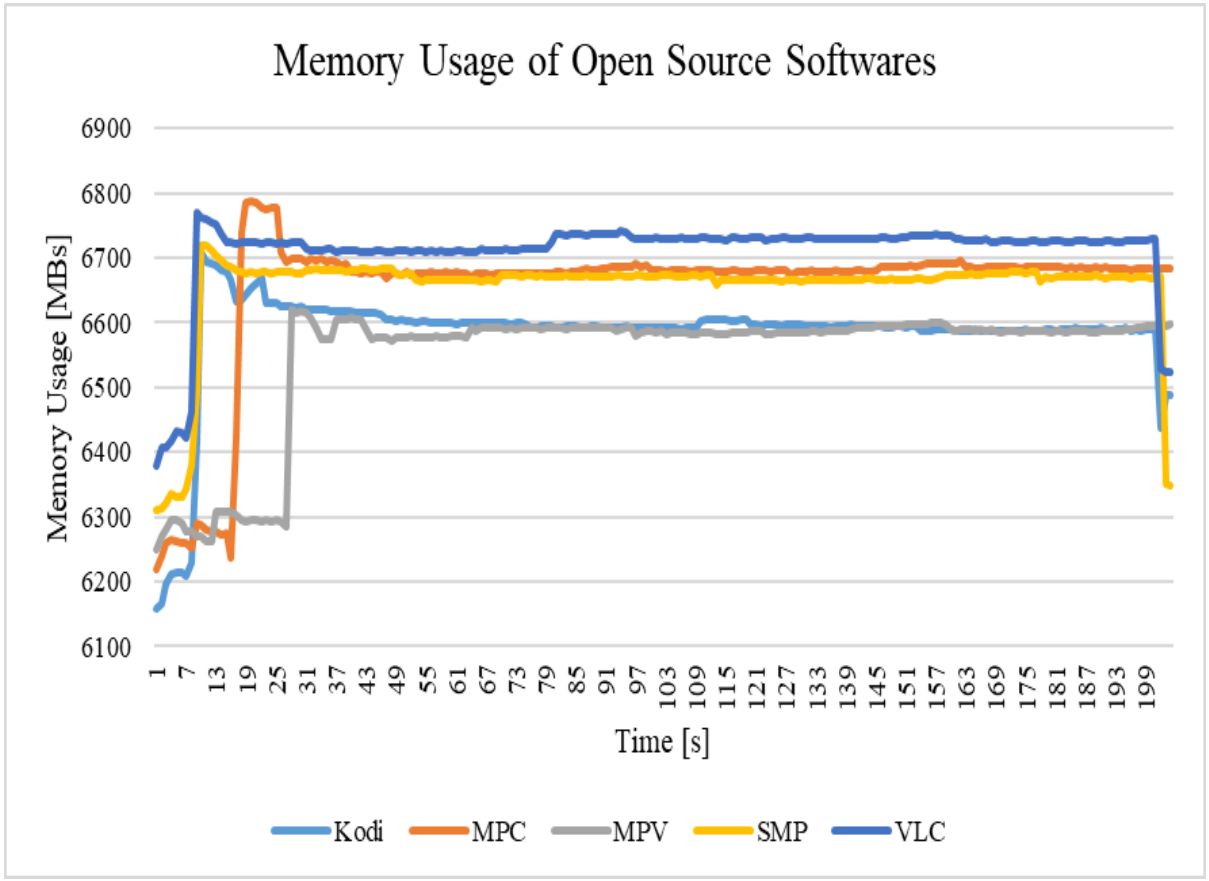
Results Comparison - Memory Utilization while playing open media format video (.webm)

- Proprietary media players consumed more power in general
- KMPlayer consuming the most memory (7562 MB).
- Windows media player being the most efficient in terms of memory utilization.



Results Comparison - Memory Utilization while playing open media format video (.webm)

- Open-source media players demonstrated a consistent behavior in Memory utilization.
- VLC consumed around 6705 MB on average.
- MPV utilized the least physical memory.



Results Comparison - Long-term Energy Consumption

- Assuming a video playback of 2 hours every day or video playback at a kiosk power consumption could be a big factor.
- VLC media player could save approximately 1.80 kWh of energy compared to KMPlayer.

Media Player	Annual Energy Consumption (kWh)	Energy Savings (kWh)
VLC	2.75	0
Kodi	3.03	0.28
MPV	4.72	1.97
SMP	4.14	1.39
MPC	4.29	1.54
Windows MP	4.19	1.43
KMPlayer	4.56	1.81
GOM Player	4.42	1.67
RealPlayer	4.53	1.78
ALLPlayer	4.35	1.6
LAPlayer	3.67	0.91
POT Player	4.44	1.69

Results – Power Consumption (Open-Source Players)

- Findings:
  - Higher CPU usage compared to proprietary players.
  - SMP and MPV showed increased power consumption during 4K playback.
  - Hardware acceleration less effective due to driver limitations on some platforms.
- Implications:
  - Open-source players may require optimization for better energy efficiency.
  - Potential for improvements through user customization and updates.

Results – Power Consumption (Proprietary Players)

- Findings:
  - Lower overall power consumption during high-resolution playback.
  - Efficient utilization of hardware acceleration and optimized drivers.
  - GOM Player and Windows Media Player demonstrated better resource management.
- Implications:
  - Proprietary players offer energy efficiency advantages out of the box.
  - Beneficial for environments where power savings are critical.

Customization in Open-Source Media Players

- Opportunities:
  - Adjust settings to disable unnecessary features.
  - Optimize codec usage and enable hardware acceleration where possible.
- Benefits:
  - Potential reduction in power consumption.
  - Tailored performance to meet specific needs.
- Challenges:
  - Requires technical knowledge and effort.
  - Inconsistent results without standardized support.

Summary of Findings

- Proprietary Media Players:
  - Superior energy efficiency due to hardware and software optimizations.
  - Better long-term energy savings in default configurations.
- Open-Source Media Players:
  - Offer flexibility and cost-effectiveness.
  - Require user-driven optimization for competitive energy usage.
- Overall Conclusion:
  - Choice depends on user priorities: immediate efficiency vs. customization potential.

Conclusions

- Proprietary media players generally consume less power due to better hardware integration, though factors like file format and operating system affect energy efficiency and need further investigation.
- Media players on windows OS are consume less power than those on Ubuntu due to better driver optimization and GPU usage, highlighting the impact of software and OS on energy savings.
- Open-source media players can use less power when playing certain formats like .MOV, especially in CPU and GPU usage, making them suitable for energy-conscious users in resource-limited environments.
- Open-source players excel in energy efficiency during 4K playback, while proprietary players consume more resources due to feature-rich environments, emphasizing the trade-off between functionality and energy savings.

Research Contribution

- Proprietary players use less power due to better hardware optimization; open-source players can be efficient with VP9 and AV1 codecs.
- Hardware acceleration reduces CPU power use in proprietary players, while open-source players face higher energy use from limited driver support.
- Proprietary codecs (H.264, H.265) minimize power use, while open-source codecs (VP9, AV1) require more CPU resources without acceleration.
- Proprietary players offer long-term energy savings through updates, while open-source players can achieve sustainability with customization and community support.

Future Work

- Mobile Media Players
  - Importance: Mobile devices are primary media consumption tools for many users.
  - Research Opportunities: Analyze energy consumption of media players on iOS and Android.
- Cloud-Based Media Streaming
  - Considerations: Need to evaluate overall energy impact, including network usage.
  - Research Directions: Study the trade-offs between local playback and cloud streaming.
- Enhancing Open-Source Players
  - Goals: Develop better hardware acceleration support and driver compatibility.
  - Strategies: Collaborate with hardware manufacturers for driver development.

List of Publications

1. *Ahmed, Afzal, Mohammad Tariq Iqbal, and Mohsin Jamil. 2024. "A Comparative Analysis of Power Consumption While Using Open-Source and Proprietary Media Players". European Journal of Electrical Engineering and Computer Science 8 (5):1-5. https://doi.org/10.24018/ejece.2024.8.5.649.*
2. *Ahmed, Afzal, Mohammad Tariq Iqbal, and Mohsin Jamil. " A Comparative Study of CPU and GPU Power Consumption while using Open-Source and Proprietary Media Players" Accepted in European Journal of Information Technologies and Computer Science (2024)*
3. *Ahmed, Afzal, Mohammad Tariq Iqbal, and Mohsin Jamil. " Comparative Analysis of Power Consumption and Resource Utilization in Open-Source and Proprietary Media Players while using Raw videos" Accepted in European Journal of Information Technologies and Computer Science (2024)*
4. *Ahmed, Afzal, Mohammad Tariq Iqbal, and Mohsin Jamil. " A Comparative Analysis of Media Players Power Consumption on Windows 11 and Ubuntu 24.04.1" Accepted in the 33rd Annual Newfoundland Electrical and Computer Engineering Conference (NECEC), 2024.*

Acknowledgements

- Supervisor:
  - For invaluable guidance and support.
- Co-Supervisor:
  - For insightful feedback and encouragement.
- Family:
  - For their unwavering support.
- Friends:
  - Especially Khan Awais Khan for his encouragement and camaraderie.
- Everyone who contributed to this journey.

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Questions

- Thank you for your attention!
- Any questions or discussions are welcome.